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ABSTRACT

Developed to provide seventh and eighth grade students information about careers in the marine science occupational cluster, this booklet may be used to integrate career information with various subject areas. (It is one of several student booklets developed for use in the Ohio Career Orientation Program at grades 7 and 8 to assist students in making tentative career decisions for exploration activities in grades 9 and 10.) Most of the guide is devoted to overviews of four career areas in the cluster, followed by description and discussion of several specific jobs in each area. The four areas are (1) marine transportation, (2) marine resources, (3) marine construction and manufacturing, and (4) marine research. Brief exploration activities are suggested through which students can learn more about the jobs. A chart is provided with notes on how various school subjects (home economics, English, social science, industrial arts, physical education, music, science, art, and mathematics) are related to the marine science cluster careers. A list of qualities needed for marine science careers and a list of sources for additional career information (professional associations and specific government bulletins) are included along with a vocabulary list and questions to aid student decision making. The text is illustrated with drawings and photographs. (JT)

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Career Orientation Series

The Marine Science Cluster

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These symbols represent seven career orientation concepts that are integral parts of the student's personal, educational and vocational development. Suggested student activities relating to the seven developmental concepts appear in the book. The corresponding symbol will identify the specific concept to which each activity most directly relates.

Self
This concept deals with how and what a person thinks of the self attitudes, perceptions and self-evaluation of interests, aptitudes, achievements and values.

Individual and Environment
This concept is concerned with an understanding of the individual as he or she relates to the environment the role each person plays in the home, school, community and work.

Education and Training
This concept relates to the learning of skills, ideas and appreciations that the individual needs in order to experience a successful life.

World of Work
This concept relates to work values, the variety and nature of occupations, work families and their interdependency, and methods of studying and classifying occupations.

Economics
This concept emphasizes the person as both a worker earning income and as a consumer dispersing income.

Employability and Work Adjustment
This concept deals with obtaining and holding a job and advancing in a career.

Decision Making
This concept relates to all the others, involving a process that is necessary to all facets of society.

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What Is Marine Science?

A look at the definitions of two words might help answer the question,

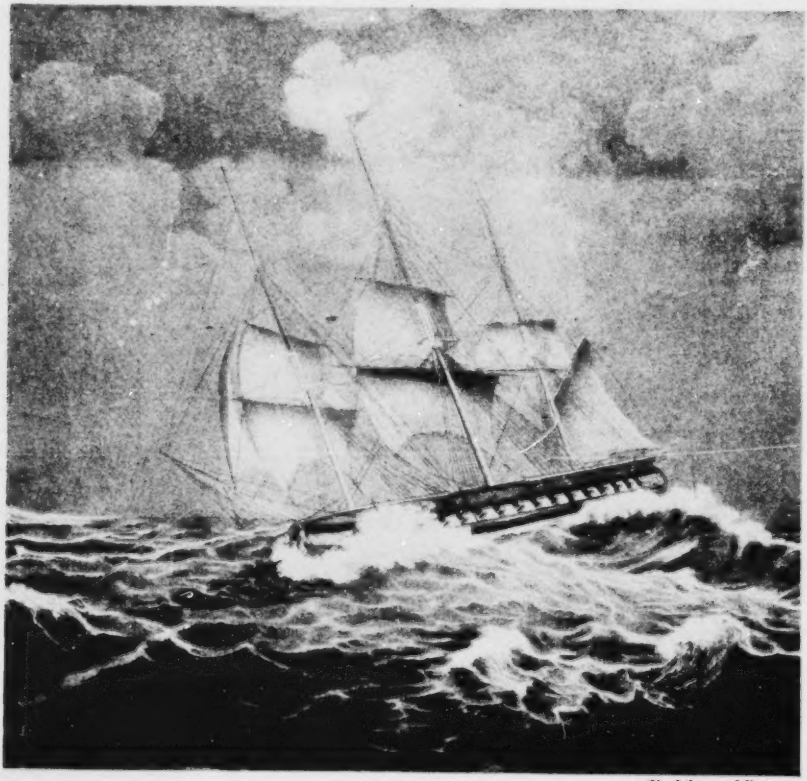
"What is marine science?"

sī'əns A science is a set of facts organized in such a way that the relationship between the facts is clear and logical.

mə rēn' Marine refers to the sea and all the things in it and on it. The sea is mostly salt water.

Marine Science is thus a set of *organized facts about the sea.* The sea has often been called the "last frontier" on Earth, because we know so few facts about it. Marine scientists (people who discover and organize marine facts) are daily adding to our knowledge, but what is known about the earth's waters is still pitifully small when compared to what is known about the land and sky.

The U.S. Constitution was called "Old Ironsides."



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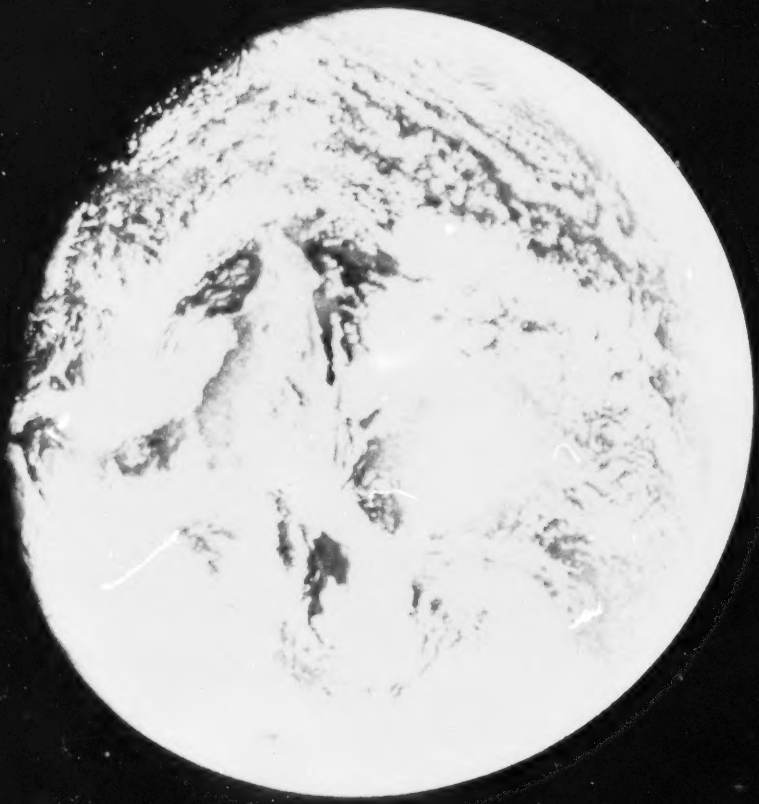


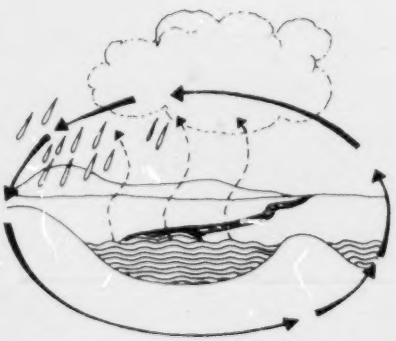
What Is This Cluster All About?

Have you ever looked at photographs of Earth taken from the moon by the astronauts? The picture to the left is such a photograph. The most striking feature of the globe is its water--ocean water on the surface and cloud water in the air. The oceans cover more than 70 percent of Planet Earth. Add to this the other water systems, like the Great Lakes and the rivers and streams, and you can see that Earth, our home, really is a "Water Planet."

So what? People live on the 30 percent that is land. What has the sea to do with us?

Much more than most people suspect. Start with the air we breathe. The human body needs oxygen, which, with food, turns into carbon dioxide. Carbon dioxide is a harmless gas that does not support animal life. Fortunately, plants can use carbon dioxide, turning it back into food and useful oxygen -- a process called **photosynthesis.** Without this process, the earth's people long ago would have run out of air to breathe. Most of the oxygen in the air comes from plants that *live in the sea.*

Consider next the weather. Without the oceans, the earth would be as dead and barren as the moon. The sea acts as a giant air conditioner. Water absorbs heat more slowly than does land, holds more heat than does land and releases heat more slowly than does land. During the daytime, especially during summer, the oceans absorb vast amounts of heat from the sun and then slowly release it at night and all winter long to warm the surrounding air and land. Most of the water vapor in the atmosphere comes from the sea and lakes. This water vapor forms rain and snow, which may fall to freshen land hundreds of miles from any body of water. Without this return of water to the land, there can be no food crops.



Water cycle

Scientists believe that living organisms first appeared in the seas many millions of years ago, before there was life on the land. Even now, there are more living

things in the sea than on land—more different kinds of things and more of each kind. The smallest animals ever to have lived, tiny one-celled creatures, live alongside the largest animals that have ever lived, the giant blue whales. Between these extremes may be found millions of other sea inhabitants of every shape and size.

The earth's human population is growing, but the land on which people live remains the same size. To feed the people and to satisfy many of their other needs, scientists are increasingly turning to the sea for answers to their problems. Someday, large floating cities may be built on the oceans. Perhaps even larger cities will be built on the ocean floor, where people will farm sea plants and raise sea animals for food. Whatever the future holds, the sea will play a major part in human affairs. Maybe your future lies waiting in the sea. That is what this booklet is all about.

Many people mistakenly believe that dinosaurs were the largest animals ever to have lived, but present day whales can grow to be much larger. Prepare a chart that shows the comparative sizes of various animals and plants. If a pencil dot represents a small, single-celled organism, how large would you have to draw the blue whale to have the same scale? You may be surprised to learn that the tallest plants are not land trees, but sea **kelp.**

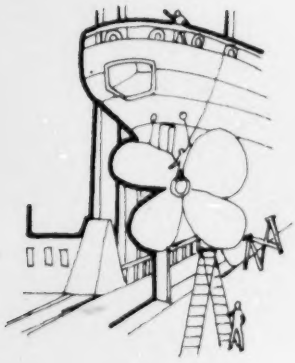
Who Works in Marine Science?

More than 70 percent of all Americans live in states that border on the sea or the Great Lakes. In addition, every state has water resources within its boundaries; thus, workers in Marine Science can be found in every state, doing important jobs for all of us.

Can you name the oceans that touch the shores of the United States? Try to name each of the five Great Lakes and several of the great rivers. Which bodies of water touch your state?

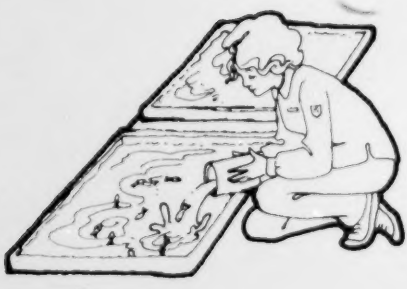
People in marine science careers are concerned in some way with the waters of the Earth.

people who operate ships



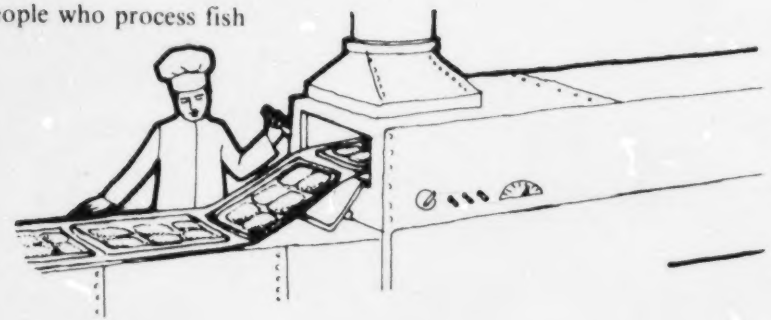
people who build ships

people who catch and harvest fish



people who raise fish

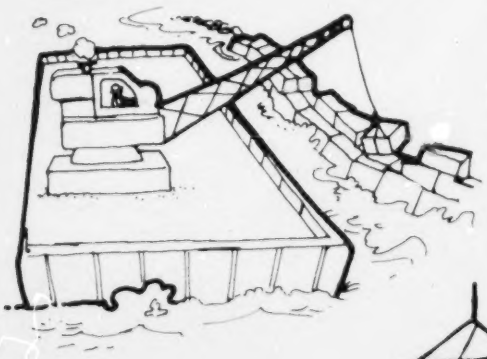
people who process fish

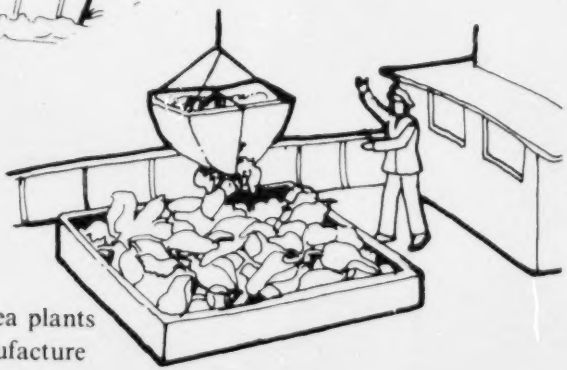


people who patrol the sea
to keep it safe

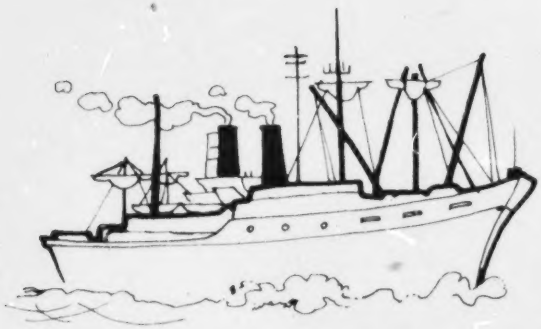
people who study the sea
and everything in it

people who build docks and
harbors

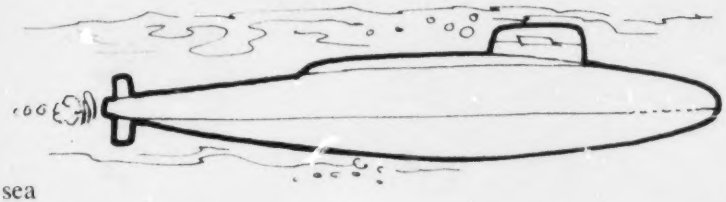




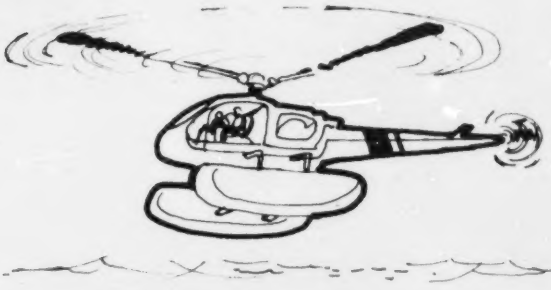
people who harvest sea plants
and people who manufacture
many things from them



on the sea

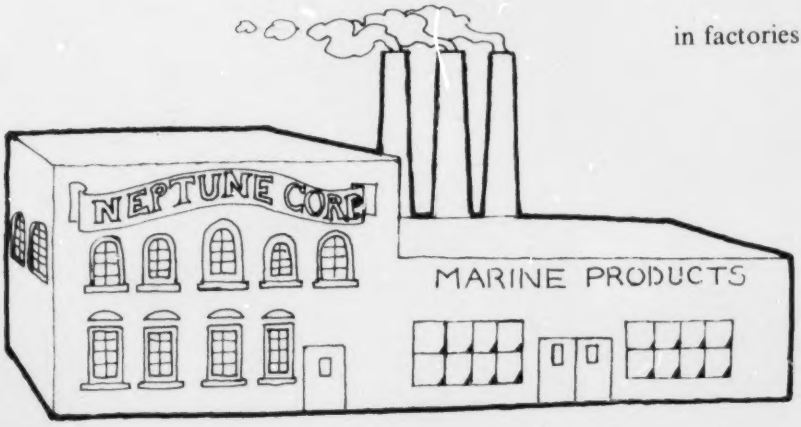


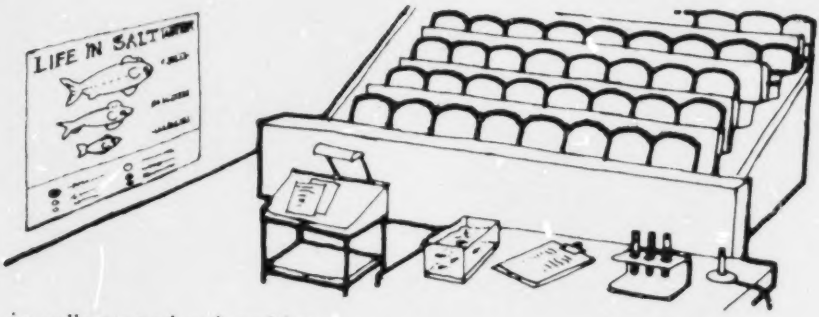
in the sea



above the sea

in factories



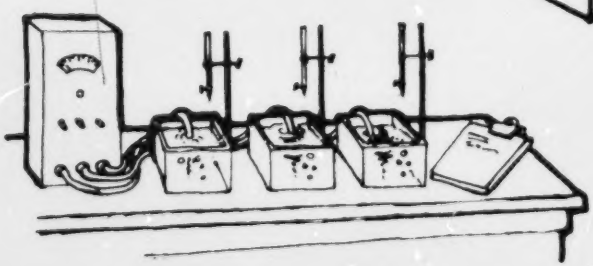


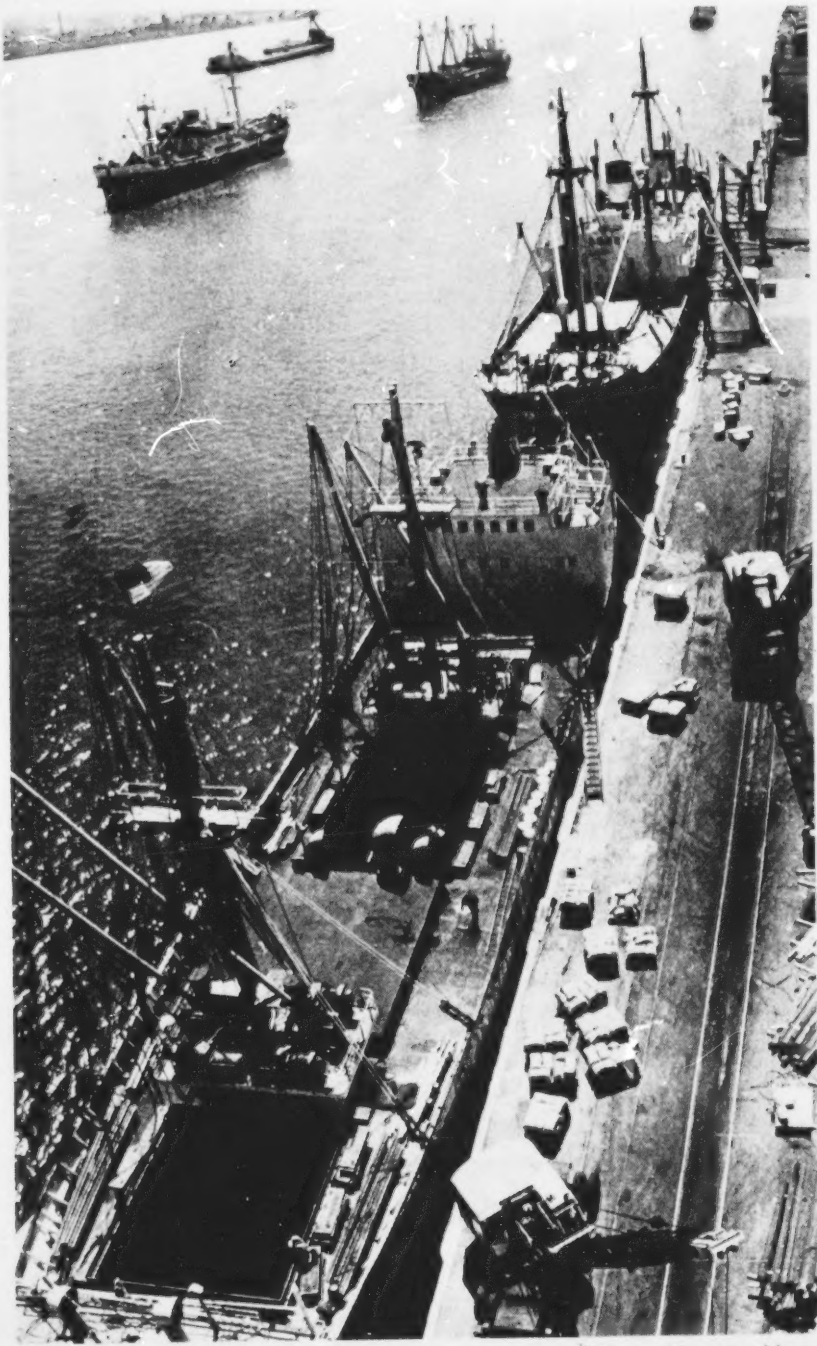
in colleges and universities

in business offices

in government agencies

in laboratories





City of Detroit Photographic Dept. Report and Information

Marine science careers provide us with many things.

What Do Marine Science Careers Do for Us?

Most people may not realize it, but marine science careers touch nearly every part of our lives.

They provide us with food:

Most fish that we eat are caught and prepared by people working in the marine science cluster of careers. Other foods also come from the sea. Ice cream, mayonnaise, pies, canned soups and margarine all have a smooth, uniform texture because an **extract** of seaweed is added to them. Even dry-land foods may require marine science because cattle and poultry are often fed **fish meal.**

They provide us with energy:

A major source of gasoline and other petroleum products is under the sea floor. Marine science careers are involved in the tapping of this needed energy source. Even foreign oil is handled by marine science workers, as it is shipped across the sea in large tankers.

They provide us with minerals and building products:

Salts containing chlorine and iodine come directly from sea water or from large salt deposits left long ago by ancient oceans. A very large salt deposit is mined day and night under Lake Erie. Sand used in making concrete and glass is collected from the floors of the Great Lakes and the oceans. Scientists believe the sea is far richer in minerals than the land has ever been. Many future marine science careers will be involved in tapping this vast mineral source.

They provide us with medicines:

Many of the medicines that maintain health come from sea animals and plants. Not many years ago, nearly every young child experienced a daily spoonful of cod liver oil. Today, several powerful drugs either are extracted from sea life or are carried in a base material that comes from the sea.

The list of ways marine science careers help us with goods and services could go on and on to include protection, weather control and warning, recreation, communication, clothing and shelter, and conservation. For a clear understanding, all these many and varied careers can be grouped into four main areas.

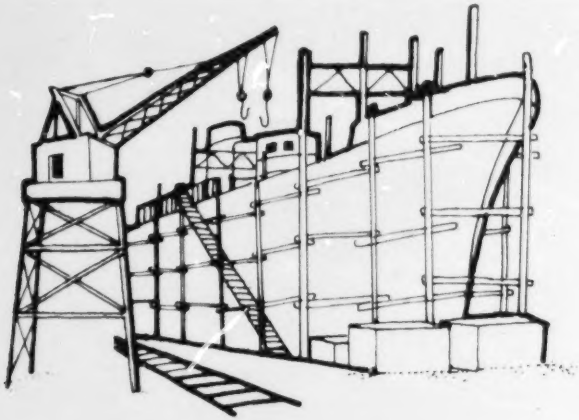
Four Main Areas
Of Marine Science Careers

Marine Transportation

the movement of cargoes and passengers on and under the seas, lakes, rivers and canals of the world

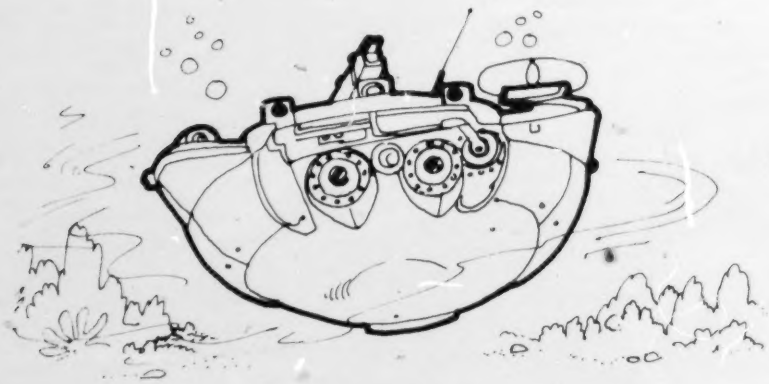
Marine Resources

the harvesting of such sea products as fish, plants and minerals



Marine Construction and Manufacturing

the building of structures and equipment necessary for people to work in, on or near the water



Marine Research

the scientific study of everything about the waters of the earth

As you read this booklet, you will learn more about these areas. You will also meet some people working in Marine Science and learn about the jobs they do.

U.S. Navy Official Photograph

The Navy helmsman stands a watch.

A Close Look at Careers In Marine Transportation

When Christopher Columbus sailed to America, he had not been searching for a new land. He and his band of seafarers were seeking a shorter trade route to India. *International trade,* more than simple curiosity, has always been the backbone of marine science.

Why should this still be true today when other forms of transportation exist for trade? The answer is money: ships can move more cargo at less cost than any other form of transportation. The merchant ships are as important today as they ever have been.

Marine transportation includes more than the movement of cargo. Though fewer people today care to take the time to travel great distances on the sea, passenger ships still require many workers in marine transportation. The work of the Navy and Coast Guard is another portion of this area, because they transport the power necessary to protect the shores and they transport the rescue facilities necessary to save lives on the open water. Another portion of marine transportation is the operation of ships and boats for pleasure or scenic cruises.

The passenger liner France leaves the Port of New York.

The Port of New York Authority

The Merchant Marine

Sailors in the U. S. Merchant Marine have come a long way from the harsh conditions under which they once worked. No longer are they whipped when they step out of line. No longer must they suffer from disease and starvation resulting from a shortage of fresh foods on long voyages.

Today's merchant **mariner** is well fed and well paid. The ships are safe and comfortable. Although a high school education is recommended, the Merchant Marine has careers in which advancement is open to the person with little formal education.

A ship's crew is divided into three departments: the *deck*, the *engine* and the *steward's* departments.

Mariners in the deck department supervise the loading and unloading of cargo. They tie the ship to the dock. They set the ship's course and keep watch for rocks, icebergs, passing ships and other hazards. Most of their work is on the maintenance of the ship, especially painting.

Deck department workers paint and repaint a ship many times. Why is this so important? The manager of a local paint store might know the various kinds of paint used on ships. Ask about the special qualities of "anti-rusting" and "anti-fouling" paints.

The crew of the engine department is in charge of the ship's power systems. The engines drive the ship through the water, provide electricity and heat, and operate the water pumps. The engine crew must lubricate moving parts, make minor repairs, and control engine speed according to orders from the deck officers.

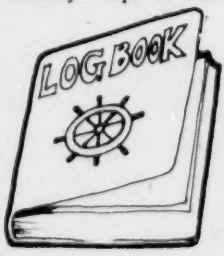
Workers in the steward's department maintain the living and dining quarters of a ship. They cook the meals and clean the **galley** (kitchen). They plan, purchase and store all foods needed for a voyage. On a passenger ship, three-fourths of the total crew may be members of the steward's department, including waiters and waitresses, barbers and hairdressers, chefs and janitors. On a freighter, perhaps as few as two or three people are in this department.

Merchant mariners are employed by the company that owns the ship, but they are hired through the union to which they belong. A sailor must also be registered with the U. S. Coast Guard and have a *Merchant Mariner's Document.*

A ship's crew is made up of seamen (sailors) and officers. Each department has seamen and officers. The captain of a ship is the chief officer to whom the seamen and officers of all three departments are responsible. The various ranks within the ship's crew are regulated by the U. S. Coast Guard. To advance to a higher rank, a person must pass a qualifying examination and usually must have spent a designated amount of time at a lower rank in order to learn necessary skills. In the deck department, for example, a person starting out as a merchant mariner must spend one year at the rank of *ordinary seaman,* or *deckhand,* before taking the Coast Guard exam for *able seaman.* The examination covers basic shipboard operations, safety regulations and lifeboat handling. Upon passing the test, a person can seek a job at the new rank, with more pay and greater responsibility.

The requirements for a ship's officer are more strict because of the greater responsibilities of the position. A college education, though not required, is recommended for anyone wanting to become a ship's officer. This is especially true in the engine department, because the modern machinery is very complex, and the Coast Guard exam is very difficult. It is possible for a person to work up through the seaman ranks to become an officer, though this path is not as common as it was years ago.

Officers are in charge of the ship and its crew. The *first, second* and *third mates* generally share command of most of the ship's operations, each standing four-hour **watches.** The *captain* is responsible for the entire ship, supervising the work of the three mates and actually taking command during docking, bad weather or unusual conditions. The officers supervise the activities of the crew and decide on daily work orders. They plot the ship's course and keep the records of the voyage, such as the ship's **logbook.** The safety of the ship, its cargo and the people on board is the primary responsibility of the officers.



There are seven special colleges for future U. S. Merchant Marine officers:

California Maritime Academy
Vallejo, California

Great Lakes Maritime Academy
Traverse City, Michigan

Marine Maritime Academy
Castine, Maine

Massachusetts Maritime Academy
Buzzards Bay, Massachusetts

State University of New York Maritime College
Fort Schuyler, New York

Texas Maritime Academy
Galveston, Texas

U. S. Merchant Marine Academy
Kings Point, New York

Write to several or all of the merchant marine schools and ask for information about admission requirements. Compare the responses you receive with your own plans for high school. Keep all the replies in a folder or notebook for future reference. All the information you receive will be of great help when you select high school courses.

Although most shipboard jobs have been traditionally open only to men, the academies are now beginning to accept women students. In the future, women will find valuable careers in the Merchant Marine.

The seven academies (colleges) offer three-year and four-year programs leading to Bachelor of Science degrees. Upon graduation and passing the U. S. Coast Guard examination for officers, a new maritime officer can begin a career as a third mate in the deck department or as a third assistant engineer in the engine department.

Life at sea demands hard work and dedication of all who enter the Merchant Marine. The biting cold of a North Atlantic wind and the searing heat of the South Pacific sun, the loneliness of months away

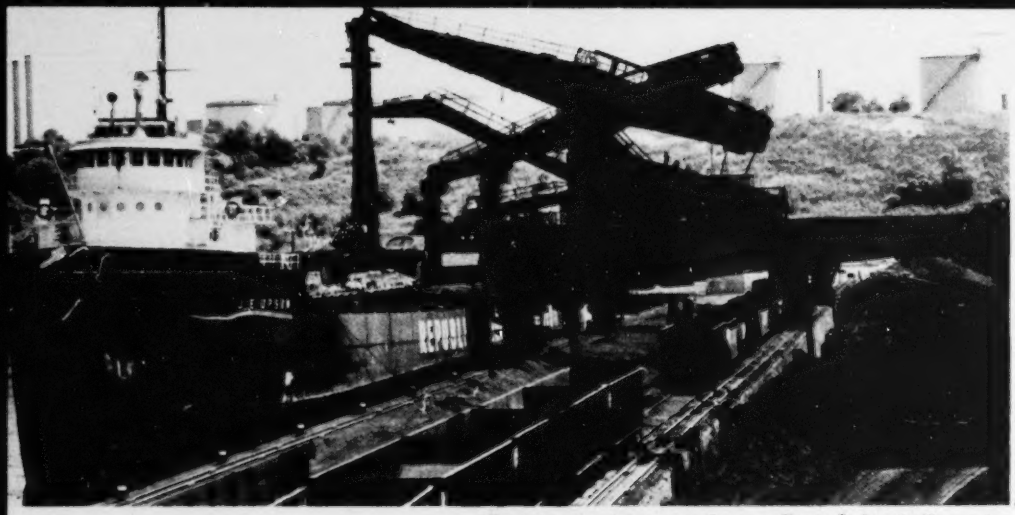
from one's family, and the constant danger of collision in a dense fog or capsizing in a raging storm are all as much of this way of life as are the freshness of a salt spray over the ship's bow, the excitement of far away cities, and the joy of returning safely home after an adventurous job well done. Whether as seamen or officers, the Merchant Marine offers exciting and rewarding careers to all who are attracted to the sea.

Captain Willis Syfert **Chief Shipboard Officer**

The "call" of the sea attracts many young people, even those born and reared far from any shore. Willis Syfert spent his childhood on a farm, but felt that a farmer's life was not for him. Several of his friends in those days worked on the Great Lakes, and through them young Willis became interested in ships and the way of life they offered.

Captain Syfert is retired now and is able to express what it is like to spend most of one's life on merchant vessels. His first job at age fifteen was as a deckhand on a lake freighter. Like deckhands throughout history, many of his first days were spent at chipping away old paint and putting new paint on the ship. When the Great Depression began in 1929, shipping jobs became so scarce that Able Seaman Syfert found himself back on the family farm for a few "dry" years. With this one brief exception, Willis Syfert was never again to leave his mariner's life until his retirement.

Captain Syfert worked his way up from rank to rank, learning the duties and responsibilities of each level as he went along. He was working as a *wheelsman,* steering the ship, during a great storm in the late fall of 1940. The ship was in the middle of Lake Michigan when the storm came up with steady winds of more than one hundred miles an hour. "Hitting each wave head-on was like running into a brick wall," he recalls. "For four hours we plunged into it at full speed, and when we checked our position by **radio direction finder** (an important navigational device), we found that we had not gone anywhere. We might as well have been standing still. Meanwhile, two ships not far from us sank from the fury of the storm." Sailing the Great Lakes can indeed be dangerous. A heavy storm can cause the steel plates of a ship's hull to bend and can tear cabins off the ship's decks. A lesson that Captain Syfert learned again and again during his long career is just how unpredictable the great waterways can be.



Republic Steel Corporation

Cranes unload iron ore from a Great Lakes bulk carrier.

Captain Syfert feels that a sailing career is the best a person can have. The pay is excellent, particularly because room and board are furnished. Most important to Captain Syfert though, has been the challenging responsibility of the various positions he has held and the excellent advancement opportunities he has had. He believes that young men and women can find equal career opportunities on the Great Lakes. "There is no job on a ship that a woman could not do as well as any man," he says.

The main drawback to a career afloat, as he sees it, is the separation from one's family. With modern loading and unloading equipment, a ship may spend as little as three hours in a **port** before leaving again. There are usually slow shipping periods during the year, however, when a sailor can spend time at home with family and friends.

During his years as a captain, Willis Syfert was totally responsible for his ship, its cargo and all the people aboard it. He would leave much of the routine operations of the ship to the officers in each department, but he would take personal command whenever there was a need for major decisions regarding the ship, its course or its operations.

Captain Syfert stayed with one company long enough to qualify for its excellent retirement program. Through a pension plan and money he has saved, he is now retired with a comfortable monthly income. Though his sailing days are over, he maintains his interest in ships on the Great Lakes. In this way, he keeps track of friends who are still afloat. If he were given a second chance to live his life, he says he would not change a thing and would again seek a mariner's life.

Cargo Handlers

Cargo handlers load and unload ships. They are often called *longshoremen* or *stevedores*. Since the amount of work each day depends upon the number of ships in port, cargo handlers are hired on a job-to-job basis. Each morning, they all report to a **hiring hall** to be assigned to work on ships. When a loading or unloading job is finished, the cargo handlers assigned to that ship have completed their day's work and must return the next morning to the hiring hall for their next assignments. How often each handler works depends on how busy the port is.

Cargo handlers belong to unions. Union members pay dues to their union. The union then deals with shipping companies and operators of port facilities to establish safe working conditions, pay scales and other job benefits for its members. Loading and unloading ships involves heavy lifting, so a person must be strong and healthy. There are no educational requirements for a career as a cargo handler.

U.S. Coast Guard and Navy

The U. S. Coast Guard is the chief government agency for marine safety. Coast Guard personnel work in many parts of the world where American ships dock and in all the harbors and waterways of the United States.

The most exciting and interesting of its missions is, perhaps, *search and rescue*. At any time a boat or ship is lost or in danger on the water, the Coast Guard goes to the rescue. This is seldom an easy job, because waterways are very large and ships are very small in comparison. For this reason, Coast Guard pilots fly seaplanes and helicopters for fast search operations and seamen operate speedy **cutters** for fast rescue, even when weather conditions are dangerous.

The U. S. Coast Guard regulates all ship operations and personnel. This is the mission of the Coast Guard Inspectors, who test the officers and crew members of American ships. Inspectors supervise all aspects of shipbuilding to ensure that builders follow safety guidelines. Inspectors determine the size of the crew required on every ship and develop special operating procedures that may be needed for safety.

The Coast Guard also operates and maintains a vast network of **navigational aids,** such as lighthouses, **buoys** and radio direction transmitters, to provide safe travel on world waterways.

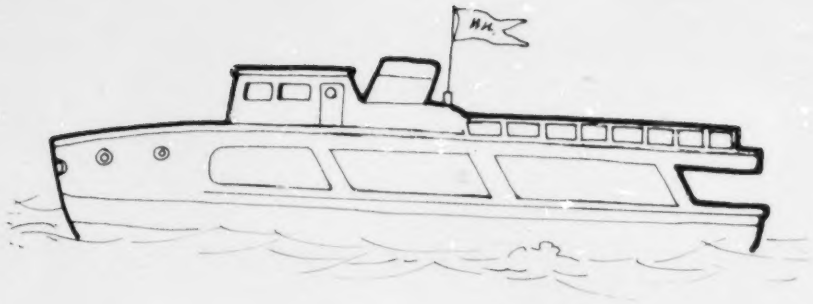
The U. S. Navy is the other sea-going branch of the American Armed Forces. Like the Coast Guard, the Navy provides all the training a person might need for a job. The Navy operates all over the world as America's first line of defense. Its peace-time mission is to keep the sea lanes open and safe for American shipping.

Visit your local Coast Guard and Navy recruiting offices to collect brochures and pamphlets about the career opportunities these services offer young men and women. The recruiting personnel can explain the training programs and job benefits that most interest you. Place all materials you receive in a folder or notebook for reference when you plan your high school program.

There are many advantages to a career in uniform. Food, housing and medical care are all provided. Advancement opportunities are excellent for both women and men. Military discipline is strict, however, and a person in the service has generally less personal freedom than someone outside the service, but has greater job security.

The 30-foot utility boat is used for search & rescue and marine law enforcement.

U. S. Coast Guard Official Photograph



Pleasure Boating

With the tremendous growth of leisure time, many people are turning to boating and sport fishing for recreation. On pleasant, sunny days, such waterways as the Ohio River and Lake Erie and the many smaller rivers and lakes between are popular recreation areas for boaters. This increased interest has created many opportunities for marine science careers.

Sales jobs	to sell boats, equipment, fishing tackle and bait
Service jobs	mechanics to repair boats and motors and managers to operate **marinas** and docks
Fishing guides and party-boat operators	to transport people to fishing areas or on sightseeing tours
Fish and game wardens and other government officials	to enforce the laws that protect water environments

All of these jobs could be listed in other career clusters, but they are appropriate to list here in marine science. In some job areas people can start their own businesses, depending only on their ability to put together initial investments and on their willingness to work hard for what they want. Are you interested in being your own boss? Maybe one of these marine science careers is for you.

Captain Annie Meylan **Party-boat Owner**

You might call her an "old salt" if you lived by the sea. For more than thirty years, Captain Annie Meylan has been running her own business—the fishing party-boat, *Lady of the Lake.* If you have the fishing gear, she will take you to the fish.

She grew up near the Great Lakes and got her first boat, a small dinghy, when she was eleven years old. She has always loved fishing and boating, and spent most of her free time on the water as she was growing up.

Fishing on Lake Erie is not what it use to be. As Captain Meylan puts it, "This lake used to be famous for its blue pike and walleye, but they were all fished out more than fifteen years ago. Since then, the most important lake fish is perch. Attempts have been made to **stock** the lake with salmon, but I haven't seen too many of them, yet." Even with changes in fish, she believes that her career is a great life for someone who loves being on the water and is willing to work hard for long hours. "I am my own boss, which is the most important thing to me," says Captain Meylan, "and I am doing what I love — fishing and boating."

On a typical day during fishing season, she is up at five o'clock or earlier, out on the lake by six, and back in port by noon. In the afternoon, she takes out a second party of people, then works into the night on bookkeeping or on the boat, cleaning and making repairs. "You never know what it is going to be like," she says. "A morning may start out nicely, but you may get a sudden thunderstorm in mid-afternoon or have an engine die later on in the day. Some days, however, are just perfect from start to finish."

Annie Meylan never finished high school, but she wishes she had. She did go back to study bookkeeping after she started her own business. "You have got to have a good head for numbers so that you can keep track of the money. Expenses like fuel, taxes, insurance and maintenance are harder to keep up with than I ever dreamed."

The U. S. Coast Guard requires a license for someone wishing to operate a fishing party-boat. To qualify for a license, a person must work on a fishing boat for at least one year and then pass an examination on basic seamanship and boat handling. The boat, of course, must also pass a Coast Guard safety inspection.

The job involves much more than just operating a boat. Captain Meylan is also a hostess and guide, and when necessary, she is even an engine mechanic. She has to be familiar with all kinds of fishing

tackle because, as she puts it, "some of these 'Sunday fishermen' do not know their arms from their legs when onboard, so you have to be ready to help them out." A fishing party-boat captain needs a cool head and the ability to take charge. "It's a job where you can only learn by doing," she says. "You have got to know the area, the boat, and most important, you have got to know the fish. If people don't catch fish, they won't come back."

Other Opportunities in Marine Transportation

There are many more opportunities in marine transportation than the merchant and military marine services and the providing of pleasure transportation. The primary tasks of research vessels and commercial fishing boats will be considered later in this book, but all such vessels have crews that are responsible for safe ship operations. Oil and mining companies operate ships to transport people and materials to offshore facilities, and these ships require crews. Marine transportation crews operate barges, tugboats, riverboats and ferryboats. These jobs generally do not pay as well as the Merchant Marine, but a person may find in one of them a job that is especially satisfying.

Just as in the Merchant Marine, these jobs are all subject to U. S. Goast Guard regulations. A marine worker must be familiar with ship handling, water safety, navigation and emergency procedures. How does one learn all these skills? Most often, by doing them in real job experiences.

Two powerful tugboats turn a merchant vessel.

Houston Chamber of Commerce

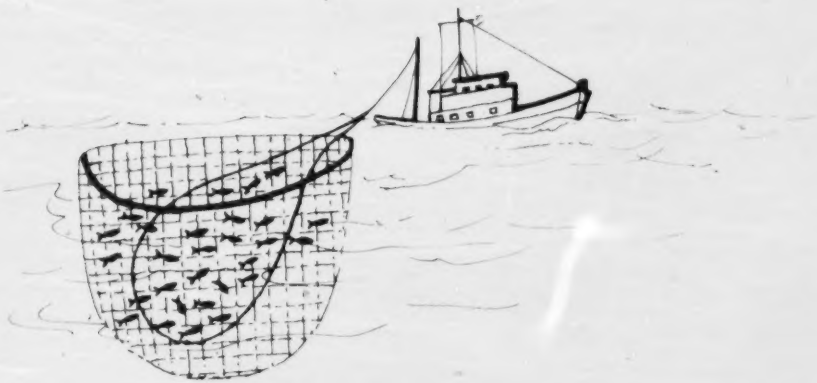
A Close Look at Careers In Marine Resources

Two important crises face the human race: the food crisis and the energy crisis. Millions of people, especially in underdeveloped nations, do not have enough to eat. At the same time, nations are rapidly using up the petroleum that runs machines and industries. Some possible solutions to these two world problems lie in the sea. People at work in marine resources are already searching for answers.

Food from the Sea

Fishing is one of the world's oldest professions. It has become for many a way of life, rather than merely a job. The work is exhausting, often wet and cold, sometimes dirty and occasionally dangerous. The hours can be extremely long, because a fishing voyage may last from dawn to dusk or it may last several weeks on the high seas, but the fishing way of life is so loved that few ever choose to leave it.

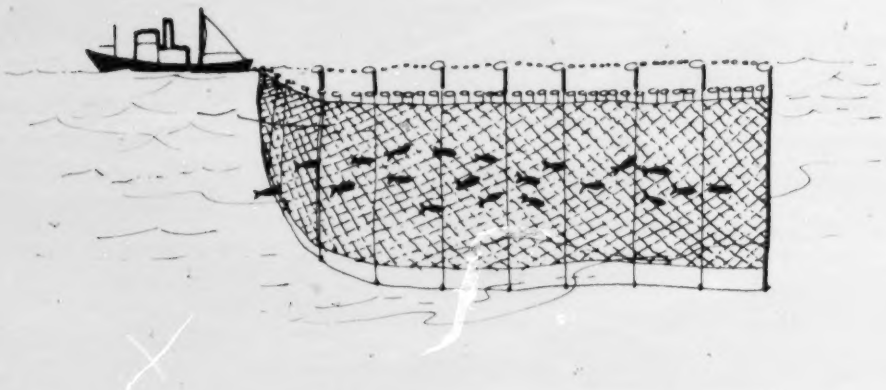
Commercial fishing methods are often named for the equipment used. The following are the four most commonly used methods.



Purse Seining

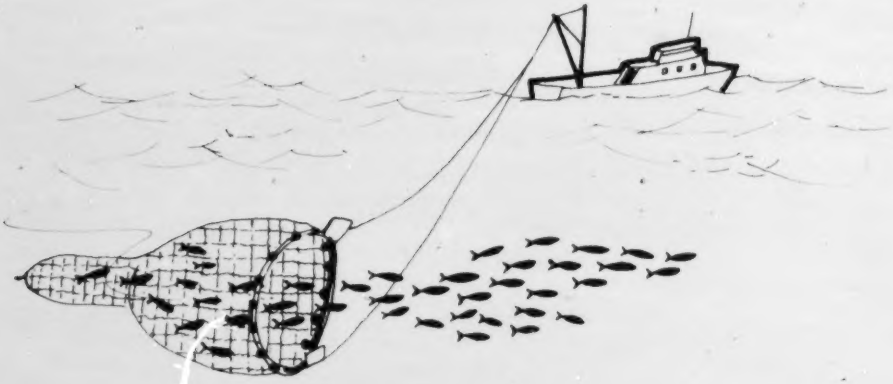
A net up to a mile in length is drawn in a circle around a **school** of fish. Once the circle is completed, the bottom edge of the net is pulled together. Since the top edge floats on buoys, the fish are

trapped in a "purse." The circle is then drawn tighter, and the trapped fish are hooked or ladled into the boat. This method is used to catch fish that travel in schools, as do herring.



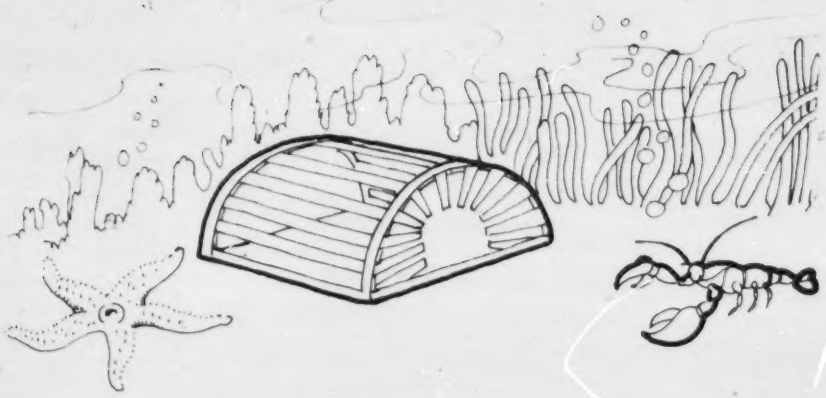
Gill Netting

A boat slowly drifts or motors along, trailing a long net that is designed to trap only fish of a certain size. Their **gills** become caught in the net. At the end of the day, the net is hauled aboard with the fish entangled in it. Salmon are often caught this way.



Trawling

A bag-shaped net is dragged across the ocean floor, scooping up fish that live near the bottom. Cod and halibut are fish usually caught by trawlers.



Trapping

Wooden or metal traps, often called pots, are baited and scattered in areas where certain sea life live. Crabs and lobsters are usually caught this way. The lobsters and crabs crawl into the traps and are unable to find their way out. From time to time, the traps are raised to the surface, the catch removed, the traps rebaited and lowered back to the ocean bottom.

The amount of money people earn in a commercial fishing career depends upon the amount of fish caught. They may *hire out* to a fish canning company, selling their daily catch at a fixed rate for an entire season. Since the market value of fish may change from day to day, they may earn less than they would if they worked on their own. On the other hand, if they do work on their own, they have no guarantee that they will be able to sell the fish after returning to port. The crew of a fishing boat is usually paid in shares of the boat's profits.

Aquaculture

Aquaculture is to the sea as agriculture is to the land. It is the controlled spawning and raising of fish and other sea animals and plants, usually for food. It is done in both artificial and natural environments.

Artificial Environments

Fish can be raised in large tanks, called **hatcheries.** The fish are separated by age into different tanks. When the fish mature, they are sent to market or are used to stock lakes and streams that have been *fished out.* The people who work in hatcheries feed the fish and maintain the tanks, filters and pumps that are needed to keep the fish alive.

Why do you think it is necessary for hatchery workers to separate fish by size? Many of the procedures used in hatcheries are also applied to small aquarium breeding. A local pet store or your school library may have a book about fish breeding and maintaining an aquarium. If this activity interests you as a hobby, perhaps you may someday wish to work in a fish hatchery.

Natural Environments

Shellfish can be raised in sheltered coastal areas of the ocean. The Japanese have been raising oysters in this way for many centuries. The main jobs in this type of aquaculture involve protecting shellfish from **predators,** such as starfish, and harvesting the shellfish when they are mature.

Aquaculture is a career field that is likely to grow in the future. Many types of fish in seas, lakes, rivers and streams are being overfished and may become **extinct.** Some kind of controlled breeding and harvesting is perhaps a solution to this threat.

Fish Processing

Once fish are caught, they are still a long way from the dining room table. In fish processing plants, the fish must be cleaned, gutted, and prepared for market. Fish may be frozen raw, or salted, smoked, dried or cooked before packaging and shipping.

There are many different types of jobs in fish processing. Fish cutters, icers, bakers and friers all do what their job titles indicate. People in these careers usually have high school educations and learn their jobs by doing them. A skilled worker may be promoted to a supervisory position that requires an increased responsibility for dealing with people. One such person is Leroy Poindexter, a *quality control supervisor.*

Leroy Poindexter — Quality Supervisor

Mr. Poindexter has never been near the sea. He does not even like to go boating because he has never learned to swim; yet, he has a career in Marine Science. He is a quality control supervisor for a fish processing plant. His job is a Marine Science career because of the products he deals with rather than where he works. His job might also be classified as a Consumer and Homemaking career or as an Agri-Business career.

Mr. Poindexter is in his early thirties. His wife, Carole, is an accountant, and they have two young daughters.

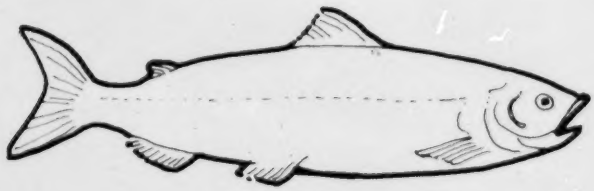
In the processing plant, sixteen-pound blocks of frozen fish meat, usually cod or whiting, are made into fish patties. The fish have been skinned, boned and cleaned before the meat arrives at Mr. Poindexter's plant. The processed fish patties that are made here are sold to institutions, such as schools and colleges, and to fastfood chains.

Mr. Poindexter is concerned with the quality of the fish patties that leave the plant. The patties must meet company and government standards for purity and cleanliness. He supervises the work of five quality control inspectors, who check each one of the several processing steps. When the frozen blocks of fish meat first arrive at the plant, Mr. Poindexter and the inspectors check block size, weight, odor and general cleanliness. A portion of a block may be cut away, defrosted and judged for water content. The portion is also checked for fish bones.

When the raw fish meat passes inspection, it is sent to the production line to be cut into patties, breaded and fried. At this stage, Mr. Poindexter must see that the patties are all of the correct size and that they are properly breaded and cooked. Some patties are checked for odor and taste. At the end of the production line, the patties are packaged and refrozen. Mr. Poindexter must see that the packages are properly labeled and dated before shipping.

Mr. Poindexter likes his job because it gives him a wide variety of day-to-day experiences. He is involved in nearly every area of the business and is often consulted when the company plans such changes as adding new products or new equipment. He keeps watch over the entire production line and even becomes involved in marketing from time to time. "You have to be ready to work hard in a job like this," he says. "Sometimes it seems like I am doing the hundred yard dash from the time I punch in to the time I go home."

Mr. Poindexter has a high school education. He trained on the job, taking special food quality courses for his present position. "If you work hard and prove to be dependable, you will move up in this field." He would like to take several courses in business and food production at a community college because he feels they would help him in his work. He believes he could become a Plant Manager in his present company, or switch to a marketing career.



Buy several boxes of fish patties made by different companies. Record the food contents as listed on the box of each sample. Weigh each sample. Carefully peel away the breaded coverings and compare the fish texture and color of each sample. These are some of the tasks of quality control inspectors to ensure that the public receives pure, clean food. Write letters to those companies that prepared exceptionally good and poor fish patties and tell them of the results of your tests.

Ocean Mining

Ocean Mining is another career that deals with marine resources. All materials found on land also are present in the sea—either dissolved in water or lying on and under the ocean floor. Magnesium is one metal that can be extracted from seawater. Many kinds of chemical salts, including common table salt, are taken from the sea. At the present time, the most important product mined from under the sea floor is petroleum.

About one-half of all the world's oil reserves are estimated to lie beneath the sea. Your school library will have several books about petroleum mining in which you can list many of the kinds of jobs that must be done on offshore oil wells. Write to several oil companies for information regarding job opportunities and training qualifications needed in this area. Save the information you receive in a folder or notebook for later reference.

People who work on offshore drilling **rigs** usually start out on land-based wells, where they learn basic skills. They then transfer to offshore operations, often because they earn more money there. An oil worker, or *roughneck*, usually stays on a rig for seven to ten days, then has three to five days on shore. While at the offshore site, roughnecks work twelve-hour shifts. The work is physically hard and sometimes dangerous and in all kinds of weather. A roughneck needs good mechanical ability, strength and an ability to get along well with people in close quarters for long periods of time.

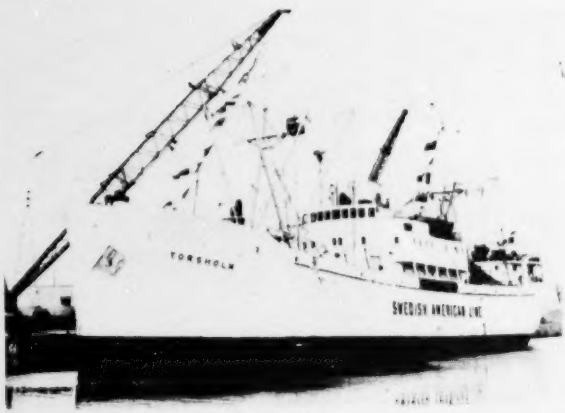
A Close Look at Careers In Marine Construction and Manufacturing

You have already learned about some of the things people do on and under the sea and with products from the sea. In this section of the booklet, you will look at people who make it all possible — workers in marine construction and manufacturing.

Ships of All Sizes

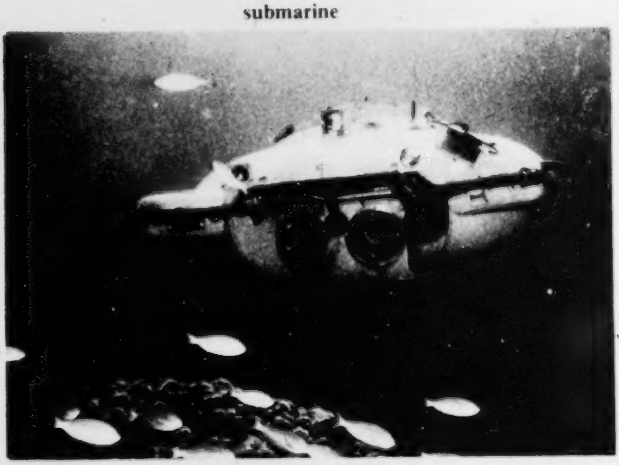
Greater Cleveland Growth Association

bulk carrier

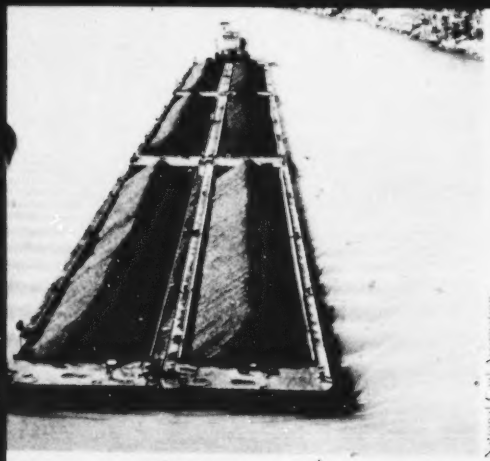


freighter

submarine



Les Requins Associés, Paris



National Coal Association

barges

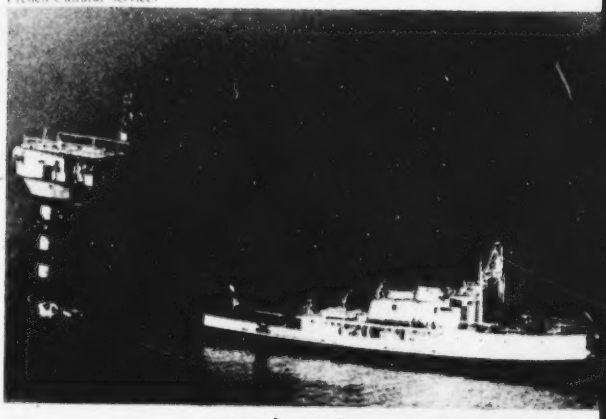
George Conn

sailboat

U.S. Coast Guard Official Photograph

buoy tender

French Cultural Services



research vessel

military vessel

U.S. Coast Guard Official Photograph

Facilities Used by Ships

Australian News and Information Bureau

harbor and docks

loading crane

U.S. Department of Agriculture

canal

National Film Board of Canada

lighthouse

U.S. Coast Guard Official Photograph

diving equipment

Environmental Science Services Administration Official Photograph

navigational and
oceanographic equipment

Environmental Science Services Administration Official Photograph

fishing gear

Equipment Used by Marine Science Workers

Anything Built in the Water

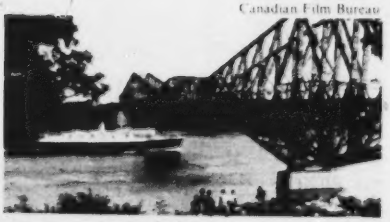
Cynthia Knapp

water treatment plant

U.S. Coast Guard Official Photograph

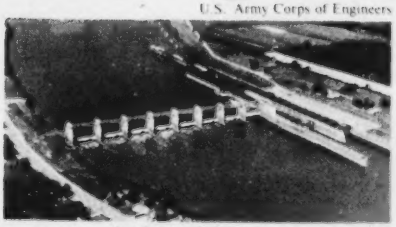
offshore harbor station

Canadian Film Bureau



bridge

U.S. Army Corps of Engineers



locks and dam

These are only some of the many things people in marine construction and manufacturing build for other marine science people.

There are three stages in marine construction and manufacturing:

Planning and Design
Production
Repair and Salvage

A very large company might be engaged in all three stages. A smaller company, such as a motor boat repair shop, would be involved in just one stage.

The number of products made by people in marine construction and manufacturing is too great to be covered completely in this book. It might be valuable, however, to look at one product as an example. Follow the production of a ship through each of the three stages. Our ship will be a large river **towboat.**

Planning and Design

Please assume that the managers of a river shipping company have decided that they need a new *boat,* which is not as simple as getting a new car or even a new airplane. (Ships on inland water ways are traditionally called boats, even though they may be as large as ocean vessels.) The first step is to hire a *navel architect* to design the boat in such a way that it will fill the exact needs of the company. It may be designed to transport one type of cargo or it may be designed to transport many kinds. It may be designed to travel only on certain types of waterways, such as the Ohio and Mississippi rivers. All of these factors and more affect its design.

A naval architect is a person with advanced training beyond a college education, and is usually employed by a ship building company or a ship designing firm. The naval architect's job is to design the towboat's hull, **holds,** living sections and **superstructure.** The architect often will build a model of the hull and test it in a large tank of water to predict how a finished ship will handle and what its best speed will be. Since the imagined ship we are to follow through production is a large river towboat, its hull will be designed to have a wide, flat bottom. Such a hull shape will permit passage into shallow river harbors.

A *naval engineer* designs the power plants and the electrical and mechanical systems of ships. Like an architect, an engineer has advanced training beyond college and usually specializes in one engineering field. While one naval engineer designs our boat's electrical system from generator to light bulb, other engineers will design the propulsion system, the network of navigational equipment, and the galley ap-

pliances, such as refrigerators and stoves. Our towboat will need, for example, special propulsion and steering systems in order to navigate tight river turns.

The naval architects and engineers are assisted by *drafting workers,* who actually draw many of our boat's **blueprints.** Although some drafting workers learn their skills in college programs, many receive their training in trade or technical schools.

Most state universities and institutes of technology have educational programs for architects, engineers and drafters. Write to several institutions and ask for information regarding the high school backgrounds they expect applicants to have before entering one of these special programs. Save all responses you receive for reference when you plan your high school courses.

Once the planning is complete, the shipping company contracts with a ship building company to build the towboat. It is ready to move from the drawing board to the **shipyard.**

Production

The production of a towboat, or any large ship, is a major undertaking and involves many more people than the workers who actually put our boat together. Many people in business careers are needed.

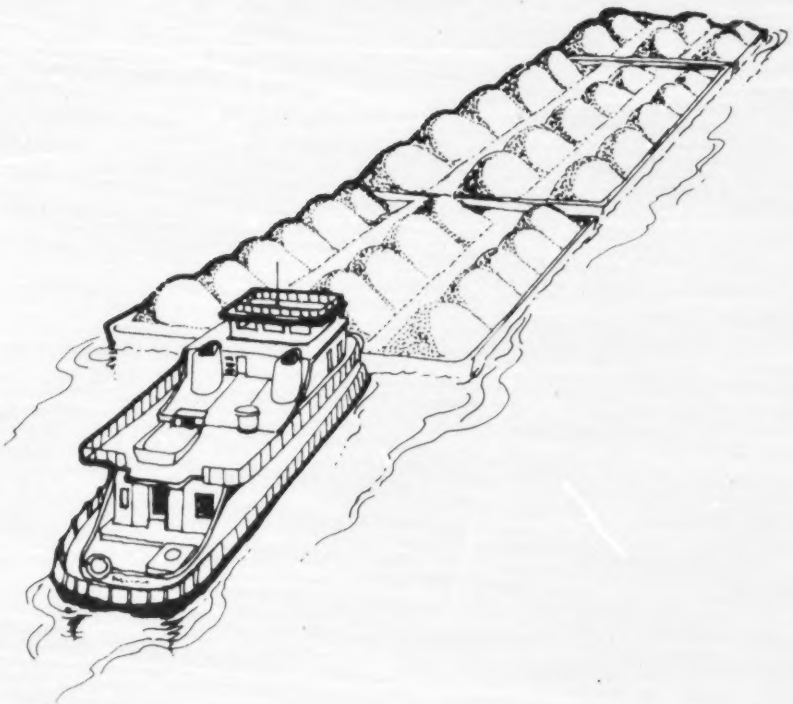
Personnel specialists	to organize the work of construction crews and to do the hiring
Financial analysts, accountants and bookkeepers	to predict building costs and to keep track of expenses
Purchasing agents	to order necessary materials and equipment with which to build the ship
Warehouse personnel	to store steel and other materials as they are purchased and to deliver them to the construction site when needed

The workers who actually build our boat have many careers:

welders
pipefitters
painters
carpenters
boilermakers
electricians
metalworkers
machinists
crane operators

These workers have high school and trade school educations and have gained further training in apprenticeship programs offered by the trade unions to which they belong.

Many sections of our towboat are built separately in different parts of the shipyard. The sections are eventually brought together and assembled on the launching ramp. When the hull is completed and our boat is nearly 80 percent finished, it is launched. Launching usually is done in a public ceremony, and the boat is christened with the traditional bottle of champagne smashed on the hull. With what name should our towboat be christened?



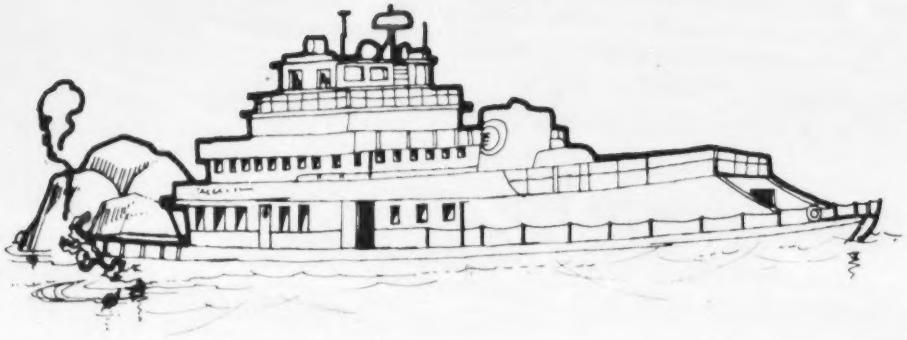
Work on our boat is far from over. The towboat must be *fitted out* —deck equipment, such as **winches** and **hatches,** is installed, electrical and navigational gear are made ready, and furnishings for living and dining quarters are put on board. When all is done, our boat is taken on a **shakedown cruise.** The crew for this voyage is made up of some members of its new permanent crew and some members of the engineering and technical crew who helped build it. The object of the shakedown cruise is to see that everything operates properly and efficiently. After necessary adjustments are made, our towboat is finally turned over to the owners to begin years of transportation up and down the Ohio and Mississippi rivers, stopping at such ports as Pittsburgh, Steubenville, Marietta, Portsmouth, Cincinnati, Louisville, Memphis and New Orleans.

Your library will have yearly copies of a World Almanac or the Ohio Almanac. Find the statistics of materials transported on Ohio waterways. You may find, for example, that a year's average barge tonnage on the Ohio River could be twice that of the Panama Canal and triple that of the St. Lawrence Seaway.

Repair and Salvage

All large ships, including our towboat, are complex machines that are built for heavy work. Parts regularly wear out and break—a cargo crane may collapse under a heavy load; engine bearings may become scratched after many hours of continuous movement; electrical navigational equipment may burn out circuits. Add to these problems the occasional damages to a boat's hull caused by submerged rocks or floating debris. Many repairs to equipment can be done on board by the crew, but some repairs can be too large for them to handle. The Coast Guard requires that all major engine repairs be done in a shipyard.

Many of the same kinds of workers that built our riverboat are involved in its repair. Naval architects and engineers estimate the damages and plan repairs. If it has been many years since our towboat



last received repairs, the architects and engineers may be asked to develop plans to modernize the boat with new engines, remodeled living quarters or improved radar and navigational equipment. Welders, metalworkers, electricians and other workers will carry out the planned repairs and changes.

Suppose now that many more years of service have passed, and the boat is no longer useful to the shipping company. It is either too old and worn, or it is damaged beyond repair after a collision or fire. Though the boat itself may not be of any use, many of its parts are valuable. At this time, a *salvage contractor* is ready to buy our towboat. The boat is stripped of everything useful: machines, equipment and power plant. What is left is then cut up and sold as scrap.

The salvage contractor also buys the right to salvage the cargoes from sunken ships. It is usually too expensive to raise sunken ships, and is normally done only when the ship is lying in shallow water where it blocks a channel or harbor. Much of the salvage work is performed by *divers.*

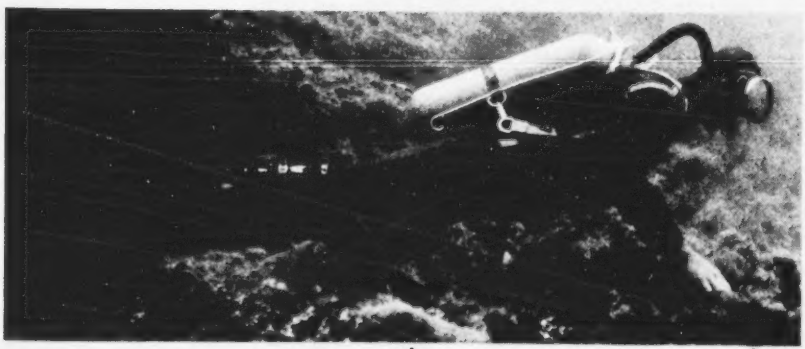
Divers

Diving is an important part of many areas in marine science. In marine construction, a diver usually has a specific construction skill that is needed underwater, such as underwater welding or underwater pipefitting. Divers are used to build bridges, docks and underwater pipelines and in underwater salvage.

There are two basic types of diving: *hard hat* and *scuba*. A hard hat diver wears a diving suit with a heavy iron helmet and weighted shoes. Hard hat divers are used in most underwater construction jobs because they have the leverage necessary for heavy work and can stay down for fairly long periods of time. They get their air through an air hose connected to pumps on the surface.

hard hat

U.S. Navy Official Photograph



scuba

Les Requins Associés, Paris

Scuba stands for "self-contained underwater breathing apparatus," which describes the air tanks that are worn on the diver's back. Scuba divers have greater freedom of movement than do hard hat divers, so much of their work is in exploration and research rather than construction. Both types of diving can be dangerous and tiring work. Divers must be strong and in excellent health. Most divers receive their training in the Navy or in private diving schools.

A Close Look at Careers In Marine Research

Scientists who study the sea are called *oceanographers.* Scientists who study fresh water systems—lakes, rivers, streams—are called *limnologists.* These are not always separate categories, because marine scientists often are involved in the study of both salt and fresh waters. The discussion in this section of the book will apply equally to limnologists (or aquatic scientists, as they are sometimes called) and oceanographers.

There are several types of oceanographers:

Chemical oceanographers are concerned with the chemical content of seawater. Every element or mineral found on land is found also in or under water.

Physical oceanographers are concerned with the physical properties and dimensions of the sea: temperature, depth, currents and wave motions. They may also be involved in problems of marine engineering.

Biological oceanographers, often called *marine biologists,* are concerned with the plant and animal life of the sea.

Geological oceanographers are concerned with the minerals of the sea, its history or its volcanoes.

Other scientists whose work often brings them into the field of Marine Research are: *archeologists,* who might salvage ancient ship wrecks; *meteorologists,* who study weather patterns; and *ecologists,* who study land, air and water environments. Even *astronomers,* scientists who study the stars and planets, have a concern with marine research—the sun, moon and planets cause **tides.**

You perhaps know that ocean tides are caused by the moon, sun and planets. Your school science book will explain the effects of gravity on large bodies of water. At what times of the day and night are the tides high and low? Are there particular days of the month when high tides are higher than on other days? Can you explain why this might be true? Do the Great Lakes have tides?

Marine scientists, like scientists in other areas, do two kinds of research. *Pure research* is aimed at discovery, at adding to the world's knowledge about something. *Applied research* is aimed at solving specific problems and has immediately practical applications to some human endeavor.

Pure Research

Though most of the land area of the earth has been explored and mapped, little of the ocean floor has been. Marine geologists and physical oceanographers might work together on a project to study and map a large section of the sea bed. First, they would select a suitable area in which to work. This is called their **station.** Next, they would cruise to their station on a research vessel that might carry a small deep-sea diving submarine. The scientists would then collect samples of the ocean floor and map the bottom contours with the aid of **sonar.** The results of their study at the station would than be brought home and, perhaps, reported in a scientific magazine. This is *one* example of pure research.

Peter McCall **Marine Researcher**

Peter McCall is a young university teacher who is just beginning a career in pure marine research. He has recently earned a Ph.D. degree in *marine paleobiology*. Paleobiology is the study of the history of life. Dr. McCall studies the history of life in the sea. By examining deep layers of the ocean bottom, he can identify the animals and plants that lived millions of years ago and also estimate the environmental conditions that existed then. Dr. McCall is also a *marine ecologist,* interested in the relationships of present-day plants and animals to sea bottom environments in which they live.

Millions of years ago, midwestern United States was the floor of a great ocean.

Dr. McCall has been to sea several times, primarily in the Western Atlantic and on Long Island Sound. He has also made several research cruises on the Great Lakes. The most important part of these cruises is the collection of samples from the bottom. The best way to do this is to dive to the bottom for the samples. Dr. McCall has already made more than one hundred dives. While at the bottom, he takes photographs, makes observations and collects rocks, bottom mud, sand, animal and plant samples. He does not really like diving because he worries at times about its many dangers. "But," he says, "the only way to study the sea is to go down to it." He does enjoy the ocean voyages to and from research stations. "I love being on the water," he says. "In fact, the opportunity to go on these cruises is one of the main reasons I became interested in this field."

In his present job as a university teacher, Dr. McCall has his own laboratory, which he is still furnishing with equipment. He is assembling a large tank in which he will attempt to **simulate** the effects of ocean currents on the ocean floor. The budget the university has given him is enough for his needs, but smaller than what he probably would receive if he were working for a large company.

He teaches a number of university classes each week. Preparing lecture notes and demonstrations takes more time than he thought it would, but he does have, however, a great deal of personal freedom to plan his research time as he wishes. "In private business or in government work, I would have to work a regular forty-hour week. Here, however, I can pretty much come and go as I choose."

Dr. McCall expects to stay in the academic world for many more years and to spend more of his time on research cruises. A person with a similar background could work in private industry. An oil company, in particular, would be likely to hire a marine researcher to find offshore oil deposits. In that event, skills and knowledge in pure research would be of practical value in applied research.

Applied Research

Shipping companies have always been troubled by barnacles—shellfish and other organisms that attach themselves to the hulls of ships, especially in tropical waters. Barnacles may add as much as three hundred tons to the weight of a large ship, and the rough surface they form on the hull causes friction and a loss of speed. One example of

applied research would be the efforts of chemical oceanographers and marine biologists working together to develop barnacle-repellent paints for the ship's hull.

Michael Moore **Physical Oceanographer**

Michael Moore is a physical oceanographer for a company that makes underwater equipment, mostly for the Navy. His specialty in applied research is **hydroacoustics,** the study of the way sound travels under water.

Mr. Moore works in a small office, crowded with several rows of filing cabinets that hold his research notes. A few cabinets have heavy padlocks, because some of his work is secret research for the Navy. Computers and other electronic equipment fill other rooms near his office.

Most of Mr. Moore's work is developing listening systems—complicated microphones that can be placed on the ocean floor to detect the passage of surface ships and submarines. In order for the microphones to work properly, Mr. Moore must calculate the effects of temperature, currents, plant and animal life, chemicals, and depth of the areas in which they will be placed. Another part of his job is to find new areas of applied research that his company may wish to study. This activity takes him into projects that are not always related specifically to marine research. Among the areas in which he has worked are sewage disposal systems, mass transit, and noise problems in factories. Each has some relationship to sound or water.

Michael Moore grew up on an island, where he developed an early interest in marine science. When in high school, he worked in a museum of natural history, which increased his interest. In college, he earned a Bachelor's degree in physics and then studied advanced courses in oceanography. He has also learned how to operate computers, because mathematics is important to scientific research.

Ocean voyages, many for long periods of time, are an important and enjoyable part of Mr. Moore's work. He has cruised in the South China Sea, the Gulf of Alaska and the coastal areas of Mexico. He loves underwater diving, which he does often. He would like to develop a way for people actually to live underwater.

Mr. Moore enjoys marine research because it is always new. "If it has been done before," he says, "then I won't do it." His work, mainly, is answering questions that no one has answered before. The

first step in finding answers is to learn what other scientists have done on the subject. In any given month, more than 1,100 articles are published on subjects on which Mr. Moore is working. That is more reading than he can ever expect to get done, so he has three librarians working to find the particular articles he may need.

The second step is to prepare a **hypothesis** about a problem. A hypothesis is something like an educated guess—an idea that can be tested. "At this stage, it looks easy. Then, when I get to work on it and begin testing, the whole thing can come apart, and I don't know what's happening. That is when the real work starts." To get that "real work" done, Mr. Moore receives a budget from his company to buy equipment for the laboratory and the research station. The company is large, and it has the money to buy the latest and best equipment.

You can estimate the expenses involved in research by calculating the costs you would have in performing a smaller experiment at home or at school. Suppose you needed to determine the effect of water temperature on underwater sounds. Make a list of the equipment you might need: large tank, water heater and thermometers, underwater speaker and microphone, sound amplifier and recorder, etc. Borrow a supply catalog from the science teacher and list the cost of each item you can find. Costs of other items may be listed in order catalogs at a hobby store. Add up the costs, and then imagine how much greater the sum would be if the same experiment were larger and performed near the ocean floor. (What is the cost of a 150-ft. research vessel, anyway?)

Mr. Moore works with a team of scientists and engineers on a part-time basis. They meet together and share ideas about their projects and try to help each other. Mr. Moore believes that "what really matters is that I have the freedom to get involved in whatever I am interested in and that the company will give me the support to do it." Mr. Moore would like to work eventually for one of the government agencies in Washington, D.C., because, "that's where most of the real action in this field is going on." Marine research is an expensive undertaking, and the federal government is one of the few agencies that has enough money to fund it properly.

Employers of Marine Scientists

Marine scientists are employed by three groups: The government, colleges and universities, and private industries and corporations.

Marine scientists are directly employed by the government when they work for the Navy or Coast Guard, or for a government agency. They are indirectly employed when they work on their own projects, for which the government has supplied funds.

Marine scientists work for colleges and universities as teachers, training new generations of scientists. They often have their own laboratories, but still usually depend on government or private grants of money to pay for their research projects.

Marine scientists may be employed by private industries and corporations to assist in improving their products and in developing new products. A scientist working for a private industry usually, but not always, has less freedom to choose research projects than does a scientist in government or university research.

A person who wants to become a marine scientist has to be prepared to work hard in school. Good grades are extremely important, particularly for someone who wishes a scholarship to help pay the often high expenses of advanced study.

There are four educational degrees in Marine research:

Associate degree is granted by a community or junior college. It normally requires two years of study after high school. It leads to a career as a technician, who works as an assistant on research projects in the laboratory and at the research station.

Bachelor degree is the basic college degree that is earned usually after four years of study. It is especially important to a person who wants a career in corporation research projects.

Master degree normally requires one or two years of advanced study after the Bachelor degree. It qualifies a person for more responsibility and often more pay than the Bachelor's degree.

Doctoral degree is the most advanced degree granted by universities. This degree is important for a person who plans to teach and do research at the college level. It is also required for a few government and corporation positions of high responsibility. To earn the degree, a person must study for three to seven years after completing a four-year college program. A doctoral student must also complete a major research project (called a **dissertation)** before the degree is granted.

Did You Know . . .
That You Have Started to Prepare For Your Career?

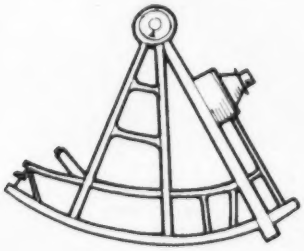
While You Are Still in School:

It may *seem* like a long time until you will be ready to start a career. Actually, your career, whatever it might be, is well underway—school is its beginning. If you think you may like to enter a career in Marine Science, then you are in luck because you have already *started.*

The subjects you are studying will help you to know what you enjoy and which talents, skills and abilities you might have for a marine science career. The skills and abilities you learn now will help you develop your special talents in this or in any other career field.

Take advantage of special courses in science, mathematics and industrial arts. Practice your writing and speaking skills in English class. Take part in groups and clubs that deal with water activities and scientific interests.

Subjects of Special Importance	**Other Useful Subjects**
Industrial Arts	Art
Mathematics	English
Science	Home Economics
	Physical Education
	Social Studies



How are these subjects used in Marine Science careers?

Some Ways That School Subjects Are Used In Marine Science Careers

Workers in Marine Science careers find that the subjects they studied in high school have helped prepare them as follows:

• **Industrial Arts**	
Marine Engineers and Architects	To utilize principles of mechanics in design and production of marine vessels and equipment
Marine Construction and Manufacturing Workers	To apply industrial arts skills to the production and maintenance of marine products
Boat Mechanics and Engine Department Crew Members	To use industrial arts skills in the repair of marine engines and power systems
Offshore Oil Workers	To utilize the principles of mechanics in the operation of heavy machines
• **Mathematics**	
Marine Engineers and Architects	To use high-level mathematical skills in marine design and production
Ship's Officers	To apply principles of mathematics to navigation and cargo placement
Fish Hatchery Workers	To compute and measure feeding quantities for different size fish
Marine Business Workers	To apply mathematical skills in accounting, clerical and sales work
• **Science**	
Oceanographers and Limnologists	To apply scientific principles to pure and applied marine research
Marine Engineers	To develop scientifically new methods of marine production and operation

Fish Processors	To apply knowledge of chemistry and biology to sanitation principles
Fish Hatchery Workers	To utilize scientific skills in the breeding and raising of fish
Ship's Officers	To use principles of meteorology by observing the stars in setting a ship's course

Other Useful School Subjects

• **Art**	
Marine Architects, Engineers and Drafting Workers	To apply art skills to drawing plans and building models
• **English**	
All Marine Science Workers	To be able to express themselves clearly and to understand others properly, both verbally and in writing
• **Home Economics**	
Fish Processors and Ship's Stewards	To apply clean and healthful techniques to food preparation
• **Physical Education**	
Divers, Cargo Handlers, Sailors and Construction Workers	To build strong bodies for heavy physical work
• **Social Studies**	
Ship's Officers and Crew and Marine Business Workers	To develop an understanding of people, both in America and in other countries
• **Music**	No direct application has been identified in this cluster

Can You See Yourself In Some of These Jobs?

Ship's Captain

Like outdoor, sometimes hazardous, work
Be willing to work many years at lower ranks
Have ability in mathematics
Desire leadership responsibility
Have, usually, a college education
Be willing to work odd hours and weekends
Receive high pay

Ship's Steward

Like cooking or other personal service duties
Be creative
Train on the job
Have some mathematical skills
Be willing to work odd hours and weekends
Like to follow directions from others
Receive generally medium pay

Motor Boat Sales Person

Have ability to speak well
Like indoor and outdoor work
Like to work with the public
Have some clerical skills
Desire regular hours, possibly on weekends
Have high school education
Receive salary or pay on commission basis

Government Fisheries Inspector

Have supervisory skills
Like outdoor work
Be willing to accept varied duties with travel
Be willing to work odd hours in seasonal tasks
Have a college education
Receive medium to high pay

Fish Baker

Like manual, indoor work
Have personal cleanliness
Train on the job
Like regular hours
Have, perhaps, less than a high school education
Receive hourly wage at low to medium pay

Fishing Guide

Like outdoor work
Be able to deal with people
Be willing to work odd hours at seasonal tasks
Be willing to accept varied duties
Be knowledgeable in the use of the outdoors
Receive hourly wage at medium pay

Marine Electrical Engineer

Have highly developed mathematical skills
Have a college education
Desire scientific and technical tasks
Like indoor work with regular hours
Like detailed work
Receive high pay

Marine Welder

Like indoor and outdoor work
Be certified by the U. S. Coast Guard
Enjoy mechanical and manual tasks
Be able to perform some precision tasks
Have technical and on-the-job training
Desire regular hours on shift assignments
Receive hourly wage at medium pay

Aquarium Attendant

Like aquatic animals
Like indoor work
Have, perhaps, less than high school education
Have some clerical skills
Desire daily routine and regular hours
Be willing to accept low to medium pay

Marine Biologist

Like detailed, scientific work
Be willing to work both alone and with others
Be willing to work both indoors and out
Have a college education
Be willing to work long hours
Receive medium to high pay

Oceanographic Technician

Have mathematical and scientific skills
Like indoor and outdoor work
Have at least two years of college
Like varied duties with some supervision
Be willing to work with others or alone
Be willing to work occasionally long hours
Receive medium to high pay

Maritime Lawyer

Have highly developed verbal skills
Be able to deal with people and their problems
Be creative and imaginative
Like indoor work
Have advanced education beyond college
Receive high pay

Marine Electronics Assembler

Have mathematical skills
Like precision, detailed work
Be willing to accept regular hours on shifts
Have high school and technical training
Receive hourly wage at medium pay

Oil Rig Worker (Roughneck)

Be physically strong
Like outdoor, sometimes hazardous, work
Have manual and mechanical skills
Have high school education and train on the job
Be able to advance to supervisory positions
Be willing to work long hours and weekends
Receive medium to high pay

Make a list of your favorite school subjects and hobbies. Identify your personal interests, skills and abilities that make these subjects and hobbies enjoyable. Are there some marine science careers that are of particular interest to you?

Take a Look at Yourself In a Marine Science Career

Who Are You Now? Who Do You Want to Be?

Marine Science offers many types of careers for many kinds of people.

There is a place for you in Marine Science:

- if you are strong and love the outdoors
  if you prefer to stay indoors
- if you like working with your hands
  if you like working with your mind
- if you like to get into the dirt and grime of heavy work
  if you like the cleanliness of precision work
- if you like to work alone or with others
  if you like to give directions or to follow them
- if you like animals and other living things
  if you like mechanical and electronic equipment
- if you like to put things together
  if you like to take things apart
- if you like the water
  even if you do *not* like the water

Invite marine science workers to your classroom. Ask them about their work. What things do they enjoy? What are the challenges that excite them? While they are talking and answering questions, carefully observe their reactions. You will probably note a dedication, an interest and an enthusiasm for their work that have made their careers satisfying life experiences.

Resources

Some Organizations That May Provide Career Information

American Association of Petroleum Geologists
P. O. Box 979
Tulsa, Oklahoma 74101

American Geological Institute
2201 M Street, N. W.
Washington, D. C. 20037

American Geophysical Union
1707 L Street, N. W.
Washington, D. C. 20036

American Institute of Biological Sciences
3900 Wisconsin Ave., N. W.
Washington, D. C. 20016

American Society of Civil Engineers
345 East 47th Street
New York, New York 10017

American Society of Mechanical Engineers
345 East 47th Street
New York, New York 10017

American Welding Society
2501 N. W. 7th Street
Miami, Florida 33125

Department of the Navy
Community Relations Division
Office of Information
Washington, D.C. 20360

International Longshoremen's and Warehousemen's Union (AFL-CIO)
150 Golden Gate Avenue
San Francisco, California 94102

International Longshoremen's Association (AFL-CIO)
17 Battery Place
New York, New York 10004

International Organization of Masters, Mates and Pilots
39 Broadway
New York, New York 10006

National Marine Engineers' Beneficial Association
17 Battery Place
New York, New York 10004

National Maritime Union of America
36 Seventh Avenue
New York, New York 10011

National Oceanic and Atmospheric Administration
6001 Executive Boulevard
Rockville, Maryland 20852

Office of Maritime Manpower
Maritime Administration
U.S. Department of Commerce
Washington, D. C. 20235

Seafarers' International Union of North America
675 Fourth Avenue
Brooklyn, New York 11232

United States Coast Guard
Public Information Division
Washington, D.C. 20590

Government Bulletins about Careers in Marine Science

Occupational Outlook Reprint Series 1785
from: Superintendent of Documents
U. S. Government Printing Office
Washington, D. C. 20402

Bulletin No.

5 Boilermaking Occupations (25¢)
12 Welders and Flame Cutters (25¢)
64 Environmental Scientists (30¢)
65 Life Science Occupations (25¢)
67 Physical Scientists (39¢)
68 Technician Occupations (30¢)
72 Boat Motor Mechanics, Motorcycle Mechanics (25¢)
140 Merchant Marine (30¢)
151 Government: Federal Civilian Employment, State and Local Government, Armed Forces (30¢)

Vocabulary

aquatic	refers to things and practices in and on the water
aquaculture	the raising of marine animals and plants, usually for food
blueprint	a photographic printing of an architect's or engineer's drawing; white lines on blue background
boat	usually, small vessel that floats on water; traditionally, the name applied to a large ship on the inland water ways
buoy	an object that floats in water, marked in such a way as to help vessels find a channel or harbor
cargo	the freight of a ship
channel	the deeper part of a waterway through which ships can pass safely
cutter	a small, lightly armed vessel used by the government to enforce customs regulations and in rescue operations
dissertation	a written essay prepared by someone earning a doctoral degree
extinct	gone, vanished, no longer existing
extract	to obtain or remove a substance from a plant or some other material
fish meal	a powder ground from dried fish
galley	a kitchen on board a vessel
gill	a part of a fish with which it "breathes" by taking oxygen from water
hatch	1. a covering over a passageway through the deck of a ship 2. the releasing of a young animal from an egg
hatchery	a place for hatching eggs, such as pools in which fish can hatch

hiring hall	a daily meeting hall in which cargo handlers are assigned to work on ships; also called the "shape-up"
hold	the space in a ship for cargo and supplies
hydroacoustics	the study of sound in water; hydro- from the Greek word for "water" and acoustics for the branch of physics that deals with sound
hypothesis	an educated guess as to the answer for some problem; a probable explanation for why something happens
kelp	a large, brown seaweed
logbook	a book in which the details of a trip made by a vessel are recorded
marina	a place where small boats are docked or moored; a boat basin
mariner	a person whose career is sailing or navigation; a sailor; a seaman below the rank of officer
navigation	the plotting and directing of the course of a ship
navigational aid	a signal that helps direct the course of a ship; a radio beam, lighthouse, buoy or similar instrument that helps a ship navigate a waterway
party-boat	usually a small vessel that carries a party, or group, of people for some purpose, such as fishing
photosynthesis	a process by which plants chemically change carbon dioxide and water into carbohydrates and oxygen
port	1. a harbor; a place where ships and boats can load and unload people and cargo 2. the left side of a vessel, facing forward
predator	a plant or animal that kills another for food
radar	an electronic device that uses the echo of radio waves to locate objects
radio direction finder	a type of radar equipment that uses radio waves to locate objects; a device for navigation of a ship

rig	1. the arrangement of masts, spars, sails, etc. on a boat or ship 2. the equipment used in drilling an oil well
salvage	to save a ship or its cargo from destruction
school (of fish)	a large number of fish that travel and feed together
seine	a fishing net that hangs in the water with floats along the top edge and weights along the bottom
shakedown cruise	a trip for a new vessel when the equipment is checked and the new crew is taught how to handle the ship
shipyard	a place where ships are built and repaired
simulate	to create a situation or model that is similar to the real thing
sonar	an electronic device that uses echos of sound waves to locate objects under water
starboard	the right side of a vessel, facing forward
station, research	the natural area in which an experimental or scientific study is taking place
stock, to	to supply a water system with fish
superstructure	the part of a vessel that is built above the deck
tide	the periodic rise and fall of large water masses caused by the unequal pull of the gravity of the moon, sun and planets on various parts of the earth
towboat	a powerful vessel used to push groups of barges on inland waterways
trawling	dragging a strong fish net along the sea bottom to catch deep-dwelling fish
watch	a period of time, usually four hours, when one part of a ship's crew is on duty
winch	a revolving machine used to hoist or haul a heavy load

The Career Orientation Program at Grades 7 and 8 was the initial component of the K-10 Career Development Program and began in Ohio in 1970. In 1972, a *Career Orientation Curriculum Guide* was written and published through the inputs of personnel in the participating school districts. The *Guide* was revised in 1973, again utilizing local personnel. From these guides, 15 USOE occupational clusters are identified as containing information necessary to assist seventh and eight grade students in making tentative career decisions for exploration activities in Grades 9 and 10.

This booklet was developed to provide students information about the career opportunities and occupational information in the cluster of "Marine Science."

This booklet can be used to integrate career information with various subject areas at Grades 7 and 8.

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Byrl R. Shoemaker

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